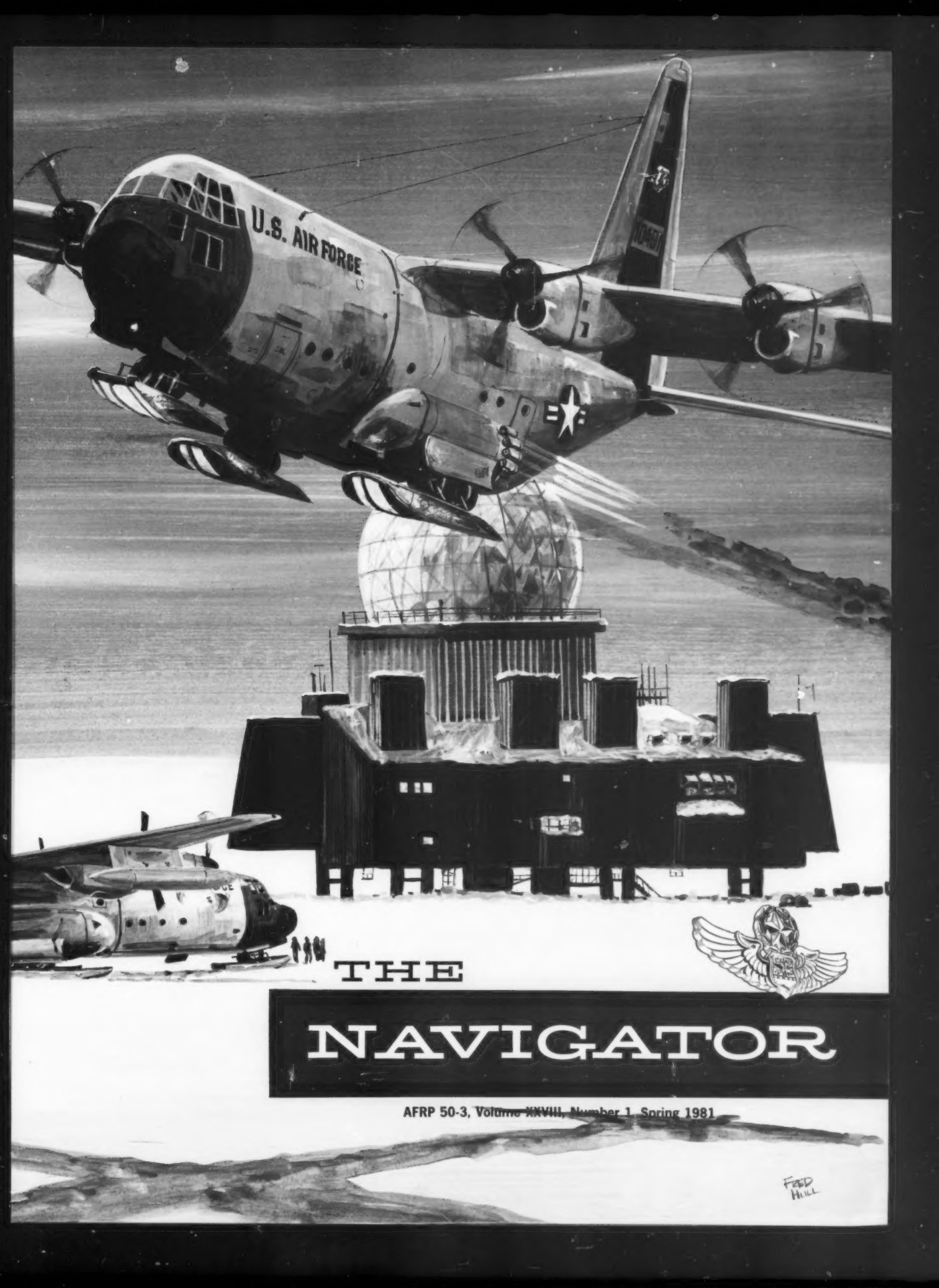

THE NAVIGATOR

AFRP 50-3, Volume XXVIII, Number 1, Spring 1981

FRED HILL

NAV OF NOTE

Lieutenant Colonel Ernest R. Perkins commands the 391st Tactical Fighter Squadron, Mountain Home AFB, Idaho. His unit flies the F-111A and is one of three fighter squadrons in the 366th Tactical Fighter Wing, the "Gunfighters." Lt Col Perkins gained earlier recognition as TAC's Outstanding Intelligence Officer of 1970 and as the USAFE Outstanding Intelligence Officer of 1972. More recently, he earned the USAF Director of Aerospace Safety's Achievement Award for 1977.

Lt Col Perkins entered UNT at James Connally AFB, Texas, in 1962 and then attended NBT at Mather AFB, California. Following NBT, he was assigned to the 30th Tactical Reconnaissance Squadron, RAF Alconbury, England, flying the RB-66C.

"My observations to this point in my career made it obvious that navigators had relatively limited opportunities in an operational career. Only in staff or support duties could a navigator expect job satisfaction as an experienced field grade officer. I was torn between a love of flying and the possibility of ending my career with a series of relatively undemanding and unsatisfying jobs."

The short, but highly enjoyable and challenging, RB-66 tour ended when the wing converted to the RF-4C with PSOs (Pilot Systems Officers) in the back seat. The wing's tactical navigators were reassigned to a variety of flying and staff jobs within the command to finish their overseas tours of duty. Lt Col Perkins was reassigned to a special air mission which carried VIPs and others throughout Europe and the Middle East flying C-47s, C-54s, C-131s and C-118s. He completed the European tour and was reassigned to Vietnam.

"Vietnam proved a major career turning point. Initially my assignment was to the EC-47, but three weeks after arrival I volunteered for reassignment to a small, specialized RB-57 detachment. The return to tactical reconnaissance challenged my training, energy and experience. It was an opportunity to work with relatively senior crew members from diverse backgrounds in an outstanding aircraft with the finest tactical sensors available. The combat tour changed my entire perspective; it gave professional and personal meaning to an Air Force career. Following SEA, I found out that the personnel system and the Air Force Form 90 really work. I applied for an AFSC and duty location, not realizing that the exact combination existed, and was assigned to the Intelligence Section of the 22d Tactical Reconnaissance Squadron at Mountain Home AFB, Idaho. This NATO dual-based unit assignment eventually provided mission-ready flying in the RF-4C and the challenge of supervising the squadron intelligence functions. The job was just what I wanted and needed at the time; it provided both excellent flying experience and a good introduction to staff, management and supervisory responsibilities in a fast-paced environment."

In 1971, Lt Col Perkins accepted a rated supplement intelligence job at the 20th Tactical Fighter Wing, RAF Upper Heyford, where he first served as Chief of Wing Targets and later as Chief of Wing Intelligence. He also flew the F-111E after a local checkout. In 1973, Lt Col Perkins earned a master's degree from the University of Arkansas. Reassigned to Nellis AFB, Nevada, in 1975 as an F-111 WSO, he worked in squadron radar strike until his selection as Chief of Safety, 474th Tactical Fighter Wing.

At this time, the Title 10 change in Congress made it apparent that navigators might have increased opportunities in operations. "My selection as Chief of Wing Safety and subsequent events have reinforced my belief that those demonstrating an interest in working the unit problems will be given further opportunity to succeed. A number of people were offered the safety position during an unstable and troubled period for the F-111 force; they declined the challenge of the position—and the opportunities it presented."

Reassigned to Mountain Home AFB as part of the "Ready Switch/Creek Swing" realignment of F-111 and F-4 resources between TAC and USAFE in 1977, Lt Col Perkins assumed duties as 366th Tactical Fighter Wing Chief of Safety until assigned as Operations Officer of the 388th Tactical Fighter Training Squadron. In May 1980, he was named 391st Tactical Fighter Squadron Commander.

"The return to supervisory positions in operations is still absolutely 'mind blowing'; it is a realization of career goals and job satisfaction undreamed of only a few years ago. It is an opportunity to work on meaningful programs and problems with no single best solution but a continuum of choices and results. A WSO or navigator is still at an inherent disadvantage in operations, but the gap is narrowing. It is now realistic to expect that opportunities exist for the aggressive navigator who performs well and works beyond the traditional scope of responsibilities. Our navigators need to take advantage of valuable supervisory experience by serving as mobile controllers, range control officers and supervisors of flying. A tour of duty as a flight safety officer is also an extremely valuable and rewarding experience for a navigator."

Lt Col Perkins views today's Air Force as operating in a highly fluid environment that desperately needs innovative, aggressive and fully committed leaders at all levels. He believes the needs of our nation and the USAF are critical and require the services of many well-trained and self-disciplined navigators. His advice to young F-111 pilots and navigators: "Challenge yourself daily—you won't be disappointed. The opportunity to serve as an operations officer or commander is well worth the time and effort you will expend. Make yourself available to do the extra work, take meticulous pride in your flying performance, and always try to relate your duties to the overall unit picture. Good luck!"

FROM THE EDITOR

Once again, the interest and enthusiam of our readers has enabled us to put together an interesting and informative issue. There is something for everyone in these pages —a look at some interesting assignments, a few technical features, several articles on unique operational units, a look ahead at NAVSTAR, and a look back at the F-89. We even have a "lost" puzzle for those so inclined. All of these articles were researched and submitted by YOU, the readers. Without this fine support, this magazine couldn't exist.

The recent Navigator Symposium at the Air Force Academy emphasized the continuing need and career opportunities for today's navs. See page 13 for more information on this annual event.

You'll notice a survey form included with this issue. Please take a moment to fill it out, for its important that we know our readers' likes and dislikes, as well as the distribution pattern. This survey is required every two years, and it allows us to see a good cross-section of our readers. Just drop it in the mail; postage is paid. Together we can have a better product and a more informed nav force. Thanks for completing the survey—and your ideas.

TO THE EDITOR

Dear Editor

This letter describes in-flight tests that verify a technique (see THE NAVIGATOR, Winter 1980) to correct celestial LOPS for acceleration error. Test results and generalized conclusions are also included.

Validation tests were flown on USAFA T-43A missions. The T-43A was chosen for these tests because of the highly accurate INS and associated nav avionics on board. Thirty-two separate collimation tests were conducted during two days. Each test included a two-minute collimation of the sun, with INS track and groundspeed noted at the beginning and end of each shot, and a corrected INS present position noted at the mid-time of each shot.

During 24 of the tests, track and/or groundspeed acceleration was purposely induced during the collimation period. The range of induced track change was from 1.6 to 103.1 degrees; the range of induced groundspeed change was from 1 to 44 knots. The resultant LOPs were in error from 3 to 776 nm. During eight of the tests, the aircraft flew an ordinary autopilot heading without induced acceleration. The range of this "natural" acceleration was from 0 to 1.3 degrees of track change, and from 0 to 6 knots of groundspeed change. The resultant LOPs were in error from 1 to 14 nm.

After correcting the LOPs for acceleration error (using the technique previously mentioned), the average error for the 24 induced acceleration tests decreased from 62 to 2.4 nm. After correction, the average error for the 8 "natural" acceleration tests decreased from 5.6 to 2.8 nm.

These test results indicate that the acceleration technique is sound. The technique does not require a checklist handout or graph. All computations can be performed on the windface of the MB-4A in less than 30 seconds. To gain the accuracy demonstrated by these tests, the navigator should have an instrument as accurate as the T-43 INS to provide track and groundspeed conditions at the beginning and end of each shot. On aircraft where the navigator shoots the celestial (other than the boomer or EWO) he or she could possibly be overtaxed in noting track/groundspeed conditions on either side of each cel shot. No judgments can be made as to the value gained by applying this technique in any aircraft without tests.

This technique provides consistently good cel when flying through areas of wind shift or when the autopilot is inoperative or malfunctioning. It is much more than mere Wander Error Correction, and is much simpler in execution.

If you believe this technique may have some application in your aircraft (or even if you just want to win the Bomb Comp Nav Leg) please contact me at Little Rock. I am also open to any earfuls of criticism you may have.

MICHAEL J. SIEVERDING, Capt, USAF
16 TATS/DOVN
Little Rock AFB, AR 72076

Thanks very much for the letter and the test results. It sounds as though you have a real workable solution to the acceleration problem. If others have used this technique with success, let us know. -Ed.

AFRP 50-3, Volume XXVIII, Number 1, Spring 1981

Department of the Air Force

THE NAVIGATOR

Proudly Serving Air Force Navigators Around the World Since 1953

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AFRP 50-3

Our cover shows two C-130Ds from the New York Air National Guard operating up in the frozen north (in Grid, of course). See page 19 for a look at this intriguing operation.

Interested in a tour at the Air Force Academy? See the next page for details.

Distribution: One copy per two navigators.

Navigator Instructor Duty at the Air Force Academy

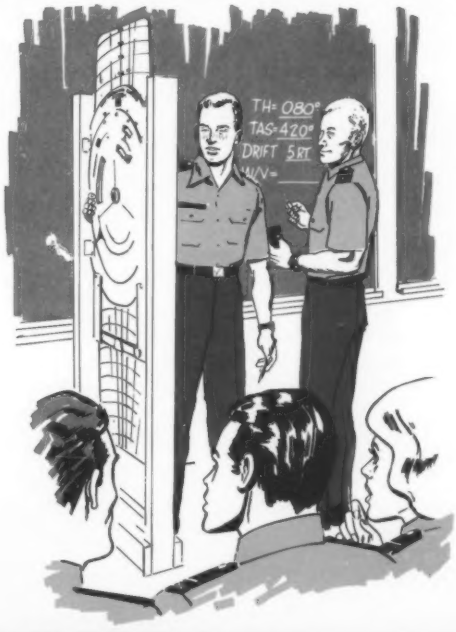
Lieutenant Colonel William H. BUTLER
USAFA/CWIN
US Air Force Academy, CO

Are you a navigator and proud of it? Interested in an outstanding career-broadening assignment? Do you like to teach? Then you should consider an assignment to the Aviation Science Division, Commandant of Cadets, United States Air Force Academy. Competition for this assignment is keen—approximately 10 applicants for each vacancy—but the duty and experience are outstanding.

Navigation instruction has a long and distinguished place in the history of cadet education and provides vital flying experience to the men and women of the Air Force Cadet Wing. The T-43 jet navigation trainer, N3-B navigation training carrels (employing mission tapes obtained from the T-45 simulator at Mather), T-4 instrument flight trainers (simulating the T-37), the Academy Planetarium, and a new Academy Observatory (with a 24" reflector telescope) are combined with classroom instruction to provide cadets with broad exposure to navigation, pilotage, astronomy, and avionics theory and practice. Over 40 instructor navigators assigned to the Academy faculty and staff earn gate credit while providing cadets with direct exposure to navigation fundamentals. A newly established USAF Navigation Symposium (sponsored annually by Academy navigators) and Cadet Navigation and Astronomy Clubs expand the role and influence of navigators assigned to the Academy. They have a vital responsibility in representing the navigator career field and motivating cadets to rated duty. It's no wonder that Academy instructor duty is valued as one of the finest assignment opportunities open to navigators today.

For those unfamiliar with the Academy, an article by Major Ben Pittman, published in the Spring 1980 issue of THE NAVIGATOR, gave a good description of the Academy's location, facilities, Cadet Wing functions, and opportunities for Air Officer Commanding duty. This article concentrates on navigation programs and duties of personnel assigned to navigation instructor duty.

The goal of the Academy flying programs is to offer all cadets experience in aviation during each of their four years at the Academy. With ever decreasing energy resources nationwide, the Academy cannot accomplish this goal without careful planning and coordinating among all flying program managers. Recently, the Superintendent approved a flying Programs Coordinating Committee proposal to realign certain flight courses for better phasing and increased flight opportunities for cadets. Enrollments for the Aviation Science Division increased 60% while flying hours decreased 15%.



For the new cadet, navigation instruction begins the first summer with Flight 8X. In 1980, 1,591 basic cadets received a one-hour orientation flight as part of this program. In 11 days, 101 sorties were completed using two T-43 aircraft operated by the Colorado Air National Guard from Buckley ANGB, Colorado. Cadet navigation instructors managed all aspects of this operation—flight scheduling, meals, transportation, emergency procedures briefings, and in-flight instruction—under the supervision of the Division officer in charge. Many cadets made a definite commitment for rated duty in the Air Force after completing the orientation.

The Aviation Science Division curriculum includes:

AV 100: Introduction to Aviation Fundamentals and Space Science

Fourth Class (first year) flight core introducing the basics of pilotage, principles of radar, navigation, and astronomy. Two T-37 instrument trainer flights. One T-43 cross-country flight mission to an operational unit.

AV 470: Applied Aviation and Navigation Theory

Principles of navigation from basic dead reckoning through radio, radar, and day celestial. Four T-43 flight missions, including one weekend cross-country.

AV 490: Avionics Concepts and Systems Development

Study of avionics systems including inertial, Doppler, radio navigation, astrotrackers, Loran, Omega, GPS, and radar. One T-43 weekend cross-country mission.

AV 493: Cadet Aviation Instructor Training

Study of navigation instructional techniques and grading procedures to qualify as cadet navigation instructor. Three T-43 missions, including one cross-country. Prerequisite: AV 470.

AV 495: Special Topics in Aviation Sciences

Study of advanced navigation principles including night celestial, pressure pattern, and grid procedures. Five T-43 flight missions, including one cross-country. Prerequisite: AV 470.

AV 498: Cadet Aviation Instructor Duty

Cadet instructors assist staff instructors in the classrooms, trainers, and flight missions and replot student missions after flight. Three T-43 cross-country missions. Prerequisite: AV 493.

AV 499: Independent Research and Study

A course in varied advanced or special topics of navigation or astronomy. T-43 flight mission(s) dependent on topic. Requires Aviation Science Division Chief approval to enroll.

AST 371: Descriptive Astronomy

An introduction to the fundamental concepts of astronomy with emphasis on the planets, stellar evolution, and galaxies. One T-43 flight mission to a space facility or major astronomical observatory includes a practical exercise in airborne celestial navigation.

AST 480: Introduction to Applied Astronomy

An advanced course stressing astronomical research. Classroom theory is applied through extensive use of the Academy's 24-inch telescope. One T-43 flight mission to a major US observatory also provides experience in celestial navigation techniques.

NAV 471: Advanced Applied Navigation

Navigation Procedures and Basic Navigation are taught using Air Training Command procedures. Validates a portion of Undergraduate Navigator Training. Four T-43 missions include two cross-country missions to Mather AFB, California. Prerequisite: AV 470.

AV 100 is a requirement for all cadets; AV 470 is required of all cadets not attending UPT following commissioning and is taken as an elective by many who do. All other courses are electives.

The success in UNT and UPT of those graduates who have completed Aviation Science Division course work has placed these courses in high demand, as shown by the following figures. During the 1980-81 school year, course enrollment will exceed 2,500 and cadets will fly 1,325 hours, including 170 cross-country missions to 35 Air Force bases. Our seven T-37 simulators are fully scheduled as pilot and navigator candidates prepare for flight training and uncommitted cadets gain motivation for flying careers.

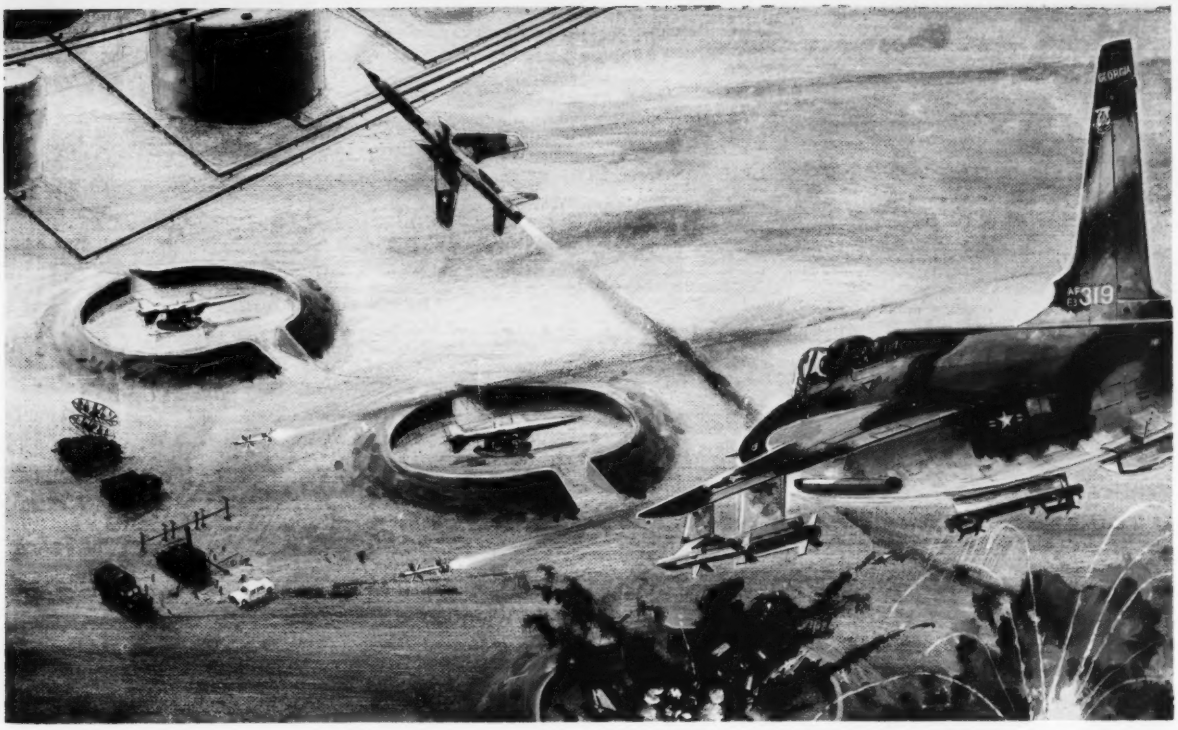
The cadets face quite a challenge in Aviation Science courses and excel in their performance. For example, AV 470 fixing and grading criteria are comparable to those used at UNT. However, all AV 470 flights—for many cadets their second in an Air Force airplane—are check rides. And each flight plays a major role in the cadets' course grades. Performance? How about a course average of 850 of 1,000 possible points on FM-1 and higher averages on subsequent missions? Top-notch student performance is expected and superior instruction is absolutely necessary.

Insuring the appropriate quality of instruction has not been a difficult task, thanks to the number of highly qualified volunteers and the preparation process. Division navs attend Instructor Training School (ITS) at Mather AFB. Those who have previously completed academic instructor training attend the T-43 AFM 60-1 portion only. AFM 60-2 training for all USAFA nav instructors is conducted at the Academy, as is 60-1 training for Staff Instructor Navigators (SINs). Initial qualification, no-notice, and annual proficiency evaluations are conducted by the Standardization Branch under the Deputy Commandant for Operations. The new instructor prepares for his first classroom teaching by observing other instructor presentations; he also presents practice lessons under the supervision of the course director.

The 32 people assigned to the Aviation Science Division, including 16 navigators, prepare and present these aviation programs. In addition, 26 Staff Instructor Navigators, assigned to other positions at the Academy, devote one-third of their time to the Division. The 323d Flying Training Wing, Mather AFB, California, also deserves special recognition. The 323d not only provides augmentee airplanes and pilots, but also coordinates the Academy's use of their T-45 navigation trainer for selected cadet training. It also provides advice and coordination on curriculum development and instructor training. All in all, the cooperation of ATC, the Academy, and the Air National Guard resulted in completion of all student training.

Getting one of these choice slots at the Academy starts by submitting an AF Form 90 through your Resource Manager at AFMPC. Once past that screening, formal application to the Academy is via the AF Form 37. At the Academy, records are compared, and those officers who appear to best fit the needs of the Cadet Wing are invited to the Academy for a formal interview with the Commandant and members of his staff. For most of the officers interviewed, PCS orders follow. But a word of caution: Academy personnel management is relatively long range, often 2-3 years downstream. You should start planning now to mesh Air Force needs and personal plans for a couple of years in the future. Unexpected openings do occur periodically, however. Call the Aviation Science Division, AUTOVON 259-3790/3582, to chat about current opportunities. You may talk yourself into one of the finest assignments in the Air Force!

Lt Col Butler completed UNT in 1965 and was then assigned to the B-52 at Blytheville AFB. In 1971, he began a four-year tour with the First Combat Evaluation Group, followed by a tour on the Squadron Officer School faculty. Lt Col Butler is currently Chief, Aviation Science Division, USAF Academy.



Captain Tom Lynn
Georgia ANG/128 TFS
Dobbins AFB, GA

THE WEASEL

The F-105G Wild Weasel heroically carved its niche in aviation combat lore over the skies of Southeast Asia. The Wild Weasels had one of the most daring combat missions ever imagined: supporting strike aircraft in high threat areas defended by antiaircraft artillery or surface-to-air missiles and suppressing those sites. The mystique of the Wild Weasel was illustrated by the enemy radar operator's reaction to the presence of Weasel aircraft. These radar sites would often stay "off the air" if convinced that Wild Weasel aircraft were in the area.

This magnificent war bird now proudly flies the colors of the Georgia Air National Guard. The 116th Tactical Fighter Wing (TFW), Dobbins AFB, Georgia, is the sole possessor of the F-105G Wild Weasel mission. As a premier unit of the Air National Guard, the 116 TFW has been awarded four Outstanding Unit Awards (1974, 1976, 1977, and 1979). The wing also received the Winston P. Wilson Trophy as the top fighter unit in the Air National Guard. It is appropriate that this highly decorated unit be charged with flying the uniquely challenging Wild Weasel mission.

In the mid-1960s, all major targets in North Vietnam were surrounded by rings of surface-to-air missiles (SAMs) and antiaircraft artillery. During this time, it became painfully obvious that some form of threat suppression tactics would have to be devised to protect the strike aircraft. Thus, the Wild Weasel mission was born. The name symbolizes one of nature's fiercest confrontations—the weasel versus the snake.

The Wild Weasel mission was first flown in 1965 by specially equipped two-seat F-100Fs stationed at Korat, Thailand. However, the greater armament capability and speed of the F-105 proved better suited to the Weasel mission. In the spring of 1966, the F-105F (the F-105 two-seat model) was modified with electronic countermeasures in the rear cockpit. These additions included the ER-142 analysis receiver, the APR 25/26 RHAW receiver, and modifications for the AGM-45 "Shrike" missile. Later modifications included adaptations for the AGM-78 "Standard Arm" antiradiation missile.

In 1970, the side-mounted ALQ-105 ECM pods were added to the Weasel airframe and the rear cockpit's ECM package was updated to include the APR-35 analysis and panoramic receiver plus

the APR-36/37 RHAW receivers. This new model was designated the F-105G Wild Weasel. In November 1970, Weasel forces from Takhli and Korat, Thailand were consolidated to form the 6010th Wild Weasel Squadron at Korat. In December 1971, it was redesignated the 17th Wild Weasel Squadron, a unit whose lineage goes back to 16 June 1917, when the 17th Aero Squadron, one of American military aviation's oldest, was formed during World War I.

A fighter pilot and an electronic warfare officer—referred to as a "Bear"—operate as a precision team in the Weasel aircraft. The "Bear" is actually a combination Electronic Warfare Officer, Weapons System Officer and Navigator. His extensive electronic warfare training enables him to identify, locate, and counter a wide spectrum of enemy threat systems.

After finding the threat site, the pilot and "Bear" then determine the most effective delivery mode for an AGM-45 missile firing, or the "Bear" can program the AGM-78 missile to guide on a specific threat radar. In a high threat environment, crew coordination and extensive knowledge of the enemy threat systems are the ticket to survival.

The 116th Tactical Fighter Wing flies daily Wild Weasel training missions. A standard profile will include a radar rendezvous and air refueling with a KC-135 tanker. A low level ingress route is then flown to either the Pincecastle, Avon Park, or Eglin electronic emitter ranges. Once on the range, the aircrews hone their weasel skills. Tactical scenarios include simulated AGM missile firings, target homing runs, and both offensive and defensive threat reaction maneuvers.

The return flight often allows the backseater to polish his "stick and rudder" skills. Since the two-seat version was originally designed as a trainer, the full complement of flight controls is available to the "Bear."

Lastly, navigation becomes the primary function when ingressing and egressing the target area at 100 feet and 600 knots. Although the Air Force first started flying the F-105 back in 1958, few aircraft can match its performance in a low altitude environment. Any F-105 pilot will quickly praise the stability and responsiveness of the Thud "on-the-deck."

JOINS THE GUARD

The traffic pattern is probably the most "eye-opening" experience for new aircrews. The F-105G flies final approach at a basic airspeed of 201 knots. To this is added a compensation factor for fuel and unexpected ordnance that may cause an asymmetrical landing condition. Thus, an F-105G landing with an AGM-78 missile and 3,000 pounds of fuel would have a final approach airspeed of 220 knots.

Much of the equipment on today's F-105G Wild Weasel remains unchanged from the original version. One major improvement has been the addition of the ALR-46 RHAW receiver. Obviously, these ECM systems, designed to specifically counter the Southeast Asian environment of the 1960s, have some limitation when combating the technologically advanced enemy threat systems of today. Although improvements and modifications constantly are being recommended and evaluated, the key to the success of the Wild Weasel mission lies in the aircrew's ability, knowledge and preparation.

The enviable tradition of the F-105G Wild Weasel, founded upon performance and professionalism, is proudly carried forward by the 116th Tactical Fighter Wing of the Georgia Air National Guard. The Weasel has found a home in Georgia.

In 1972, Capt Lynn completed UNT and EWOT. Assigned to Korat RTAFB, he flew the F-105G followed by return assignment to the B-52. After CCTS, he joined the Kansas ANG flying EB-57s and later the KC-135. Capt Lynn presently flies the F-105G with the Georgia ANG.

lost air almanac procedures

First Lieutenant James M. WRIGHT
20 BMS
Carswell AFB, TX

Somewhere before your first ADIZ penetration and after your INS or calculator failure, you may find yourself without an Air Almanac. Whether you used the almanac for a brace on your woodworking project, or the crew chief didn't replace the outdated volume in the aircraft, you are now in the middle of the ocean with only a sextant, your H.O. volumes (sight reduction tables), and an hour-old fix. What to do?

You have three alternatives. First, you could panic. Second, you could DR the length of the Pacific. Third, you could turn to table 4 in the back of your H.O. volumes. Now if you didn't attend Nav School at Connally or Harlingen Field, or if you just happened to miss a discussion on the subject, you might not realize what you can do in a lost Air Almanac situation.

Table 4 in the H.O. volumes will provide the GHA of Aries and the sun, as well as the declination (dec) of the sun. It is accurate within two minutes of arc. Please note that these tables are great backups, but they do take a little more time and work than the Air Almanac.

The GHA of Aries is the easiest to derive and it is found in H.O. Volume I. You simply add three numbers extracted from three tables. Table 4a is entered with the month and year and gives the GHA of Aries at 00h (hour) for the first day of each month (Figure 1). Entering table b with the Zulu day and GMT you get GHA of Aries for days and hours (Figure 2). Table c entered with minutes and seconds provides the third and final additive value (Figure 3). Total the three values provided by the tables and you have the GHA of Aries for your preselected time. As an example, compute the GHA of Aries for 1 January 1980, 0204 Zulu.

Year	Jan. 1	Feb. 1	Mar.
	° ′	° ′	°
1977	100 32	131 05	1
1978	100 18	130 51	
1979	100 03	130 36	1
1980	99 49	130 22	1
1981	100	131 07	

Figure 1
Table a

Day	1	2	3
h	° ′	° ′	
00	0 00	0 59	
01	15 02	16 02	17
02	30 05	31 04	32
03	45 07	46 07	47
04	60 10		

Figure 2
Table b

	00°	04°	08°
m	° ′	° ′	° ′
00	0 00	0 01	0 02
01	0 15	0 16	0 17
02	0 30	0 31	0 32
03	0 45	0 46	0
04	1 00	1 01	1
05	1 15	1 1	

Figure 3
Table c

Table a 99°-49′
Table b + 30°-05′
Table c + 1°-00′
total 130°-54′

GHA of Aries from the Air Almanac is 130-53.6

The value derived should be 130°-54'.

Unfortunately, the GHA and the dec for the sun are not as easily derived as the GHA of Aries, and the instructions in the H.O. volumes may be confusing when you are 40 minutes from the ADIZ. Instead of three tables, you now have five and they are a bit tougher to use.

In this sample problem we will find the GHA and dec of the sun for 1 Jan 1980 at 2030 Zulu. From table 4a (volume II or III) you get a correction (in hours) to GMT. For leap years two values may be obtained, one before and one after 29 February (Figure 4). For this example, the value is -11. This number is applied to the rounded off Zulu hour (30 minutes is rounded up) with orbit time (OT) as the result (Figure 4). The Zulu hour may be rounded up or down, but for simplicity we will round up. Sometimes rounding down will be more accurate, but either way you will be within ± 2 minutes of arc. Orbit time and E (to be discussed later) are correction factors and entering arguments used in deriving GHA and dec in these tables. Orbit time is formed by applying the hour correction from table A to the nearest integral hour of GMT.

Depending on the day and time, orbit time (corrected GMT) can put you a day or a month ahead or behind. Table 4 is only concerned with

a. Corr. to GMT

Year	Corr.	Year	Corr.	Year	Corr.
	h		h		h
1965	+ 4	1977	+ 7	1989	+ 9
1966	− 1	1978	+ 1	1990	+ 3
1967	− 7	1979	− 5	1991	− 3
1968	−13	1980	−11	1992	− 9
"	+11*	"	+13*	"	+15*

*After Feb. 29

Figure 4

GMT 1980, JAN 1 2030 (month, day, time)
rounded GMT " " 2100 (nearest integral hour)
Table a " " -11 (hours)
Orbit Time 1980, JAN 1 1000 (O.T.)

O.T.	JAN		FEB	
00h	E	Dec.	E	Dec.
d	° ′	° ′	° ′	° ′
1	4 11	S 23 03	1 37	S 17 16
2	4 04	22 58	1 35	16 59
3	3 57	22 53	1 33	16 42
4	3 50		1 31	

Figure 5
Table 4

Value *E
4°-11′
4°-04′
decreasing value, 5 is negative

Value *dec
23°-03′
22°-58′5
decreasing by 7'

Δ is the difference between consecutive values of E or dec.

E 4°-11′
dec S23°-03′
Δ dec -5′ (down, to the right)
Δ E -7′ (not shown)

the orbit time, month and day. So, entering with January on top and day one on the side, four values are extracted. Two of these values, E and dec, are straightforward. E equals 4° 11' + equation of time. The other two values extracted from table 4 are the difference in dec and the difference in E. The number to the right of dec is the difference in dec. The difference in E is not shown. You must compute this from the values shown. The sign also must be noted. If the difference is increasing, it is positive; conversely, if it is decreasing, it is negative (Figure 5).

Now table b is entered with the orbit time (1000) and with the difference in consecutive values of E (-7). The value extracted is a small correction to E in minutes (Figure 6).

Diff.	1 2 3	4 5 6	7 8 9	10
h	' ' '	' ' '	' ' '	'
0	0 0 0	0 0 0	0 0 0	0
1	0 0 0	0 0 0	0 0 0	0
2	0 0 0	0 0 1	1 1 1	1
3	0 0 0	1 1 1	1 1 1	1
4	0 0 1	1 1 1	1 1 2	2
5	0 0 1	1 1 1	1 2 2	2
6	0 1 1	1 1 2	2 2 2	3
7	0 1 1	1 1 2	2 2 3	3
8	0 1 1	1 2 2	2 3 3	3
9	0 1 1	2 2 2	3 3 3	4
10	0 1 1	2 2 3	3 3 4	4

Figure 6
Table b

E 4°-11'
Table b -3'
= 4°-08'

Tables c and d are entered with your original GMT. The values extracted are added to E, giving the GHA of the sun (Figure 7).

Table c

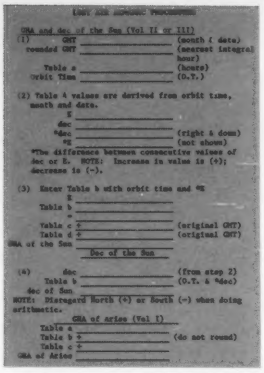
	00m	10m	20m	30m	40m
h	° '	° '	° '	° '	° '
00	175 00	177 30	180 00	182 30	185 00
01	190 00	192 30	195 00	197 30	200 00
	205 00		210 00		
19	100 00	102 30	105 00	107 30	110 0
20	115 00	117 30	120 00	122 30	125
21	130 00	132 30	135 00	137 30	140 0
22	145 00	147 30	150 00	152 30	155 0
23	160 00	162 30	165 00	167 30	170

Table d

m s	° '	m s	° '	m s	° '
00 00	0 00	01 37	0 25	03 17	0 50
01	0 01	41	0 26	21	0 51
05	0 02	45	0 27	25	0 52
09	0 03	49	0 28	29	0
13		53			

Figure 7

E 4°-08'
Table c 122°-30'
Table d 0-00
GHA of the sun 126°-38'
GHA in the Air Almanac 126°-38.5"


GHA and dec of the Sun (Vol II or III)
(1) GMT (month & date)
rounded GMT (nearest integral hour)
Table a (hours)
Orbit Time (O.T.)
(2) Table 4 values are derived from orbit time, month and date.
E
dec
*dec (right & down)
eq (not shown)
*The difference between consecutive values of dec or E. NOTE: Increase in value is (+); decrease is (-).
(3) Enter Table b with orbit time and eq
E
Table b
Table c + (original GMT)
Table d + (original GMT)
GHA of the Sun
Dec of the Sun
(4) dec (from step 2)
Table b (O.T. & *dec)
dec of Sun
NOTE: Disregard North (+) or South (-) when doing arithmetic.
GHA of Aries (Vol I)
Table a
Table b + (do not round)
Table c +
GHA of Aries

REFERENCE GUIDE FOR CHECKLIST

As you can see, our answer was quite accurate when compared with the Air Almanac value. Declination still must be resolved, but fortunately it is done in one step.

Enter table b again, but this time with orbit time (1000) and the difference in consecutive values of dec (-5). This value applied to the dec extracted from table 4 gives the declination of the sun. Remember to disregard North (+) or South (-) when doing the arithmetic (Figure 8).

Diff.	1 2 3	4 5 6	7 8 9	10
h	' ' '	' ' '	' ' '	'
0	0 0 0	0 0 0	0 0 0	0
1	0 0 0	0 0 0	0 0 0	0
2	0 0 0	0 0 1	1 1 1	1
3	0 0 0	1 1 1	1 1 1	1
4	0 0 1	1 1 1	1 1 2	2
5	0 0 1	1 1 1	1 2 2	2
6	0 1 1	1 1 2	2 2 2	3
7	0 1 1	1 1 2	2 2 3	3
8	0 1 1	1 2 2	2 3 3	3
9	0 1 1	2 2 2	3 3 3	4
10	0 1 1	2 2 3	3 3 4	4

Figure 8
Table b

dec S23°-03'
Table b -2'
dec of the sun S23°-01'
dec from the Air Almanac S23°-01.1"

A guide is provided for your use, since the example in the H.O. volumes is incomplete. Try using it a few times. After you are comfortable with this guide, consider placing it in the back of your checklist for emergency use. After one embarrassing flight, you'll wish you had!

Lt Wright graduated from Texas A&M University in 1977. After completing UNT and NBT in 1978, Lt Wright was assigned to Carswell AFB. He presently is a B-52D instructor.

NAVIGRAMS

We are proud to present the navigator leaders recently selected for promotion to brigadier general and colonel, respectively. Congratulations and best wishes for continued success from THE NAVIGATOR.

BRIGADIER GENERAL SELECTEES

Colonel Aloysius G. Casey
Asst DCS/Sys (AFSC)
Andrews Air Force Base, Maryland

Colonel Henry J. Sechler
Sp Asst to Dir of Prgms, HQ USAF
Washington, DC

Colonel William P. Bowden
Asst DCS/Log Ops (AFLC)
Wright-Patterson Air Force Base, Ohio

Colonel James G. Jones
Chief of Staff, TAC
Langley Air Force Base, Virginia

Colonel William M. Shaw, Jr.
Comdr, Log Sup Gp
APO New York

COLONEL SELECTEES

Alexander, James W.
Anderson, Edward L.
Anselmo, Robert J.
Bacheller, Burton P. C. II
Bailey, Jerry T.
Bainbridge, Thomas A.
Berry, John S.
Bevans, John P.
Blahous, Edward G.
Blaker, Philip C.
Bobick, James C.
Boles, Dyek R.
Brawley, Horace M.
Britz, William C.
Brotnov, Kenneth W.
Brown, Lloyd A.
Burke, Michael F.
Bush, Robert W.
Butt, David W.
Carey, John J.
Carver, James I. II
Carver, Jimmy D.
Clark, Wayne E.
Clement Robert O.
Creel, Joel D.
Faessler, Lawrence J.
Fullerton, Ronald A.
Galante, Leonard T.
Galemmo, Joseph A.
Gardner, Maurice G.
Ginzel, Weldon J.
Goff, Elton S.
Gropman, Alan L.
Guertin, Richard J.
Harris, Alan
Hendryx, Francis A.
Hensley, Dale L.
Hood, Joseph L.
Hubert, John S.
Johnson, Calvin R.
Johnson, Jay H., Jr.
Klug, Robb F.
Knudson, George H., Jr.
Krouse, Kieth E.
LaChance, Andre L.
Lane, Jon S.
Leahy, Robert G.
Lefton, Jerry D.
Locke, Robert M.
Louden, Philip E.
Lyman, Roderick W.
Mabile, Arnold L.
Maiorka, Philip S.
Masciola, Mario V.
McDowell, Richard E.
Miller, Max I., Jr.
Nagel, Lester E.
Owen, Tofie M., Jr.
Plummer, Donald G.
Pochop, Harold D.
Prindle, Hoyt L., Jr.
Raymond, Richard A.
Rech, Adam
Rivera, Danny
Rockstad, Jon G.
Rounds, Gordon M.
Schichtle, Casper J., Jr.
Schwarzenback, Roger J.
Scuderi, Richard
Sellers, Lester H.
Sexton, Richard R.
Sherman, Wiley, Jr.
Smith, Wayne O., Jr.
Stallworth, Willett R.
Stephenson, Russell G.
Swett, David W., Jr.
Teitler, Barry M.
Thompson, Richard L.
Wakefield, James L.
Wheeler, Kenneth R.
Wiener, Robert D.
Winters, William N.
Zersen, William F. H.

More than 100 navigators met at the U.S. AIR FORCE ACADEMY on Dec 8-12 to discuss their profession and career opportunities during the third annual Air Force Navigator Symposium. Representatives of Air Force headquarters, major air commands, Reserve, and Air National Guard, including several general officers, discussed promotions, assignments, policies, evaluation reports, and command opportunities. In addition, some 100 Academy cadets participated in portions of the symposium, including a breakfast and dining-in.

Brigadier General Keith D. McCartney, Recruiting Service Commander, told the group, "With all the initiatives developed as a result of symposiums such as this, the future of Air Force navigators is promising. But you must remember," he advised, "the success you attain in the Air Force depends not only on being a good navigator but also on being a good officer."

"All professionals are measured by how well they know their business, and you are going to be measured against this yardstick for the rest of your careers," General McCartney said. "When it comes time to select someone for promotion or a big job, the one who is recognized as knowing his business is most likely to be the one chosen for the more important, more visible opportunity."

Lt Col William H. Butler, Academy Aviation Science Division Chief, said that the navigators who attended the symposium believed it was a success and should be continued in the future. "I felt the attendees left with a greater sense of motivation and greater pride in their profession," he said. "They gained a better understanding of the personnel system and a considerable amount of positive feedback to take back to their operational units."

NAVIGRAMS Continued On Page 28

Captain William J. KASSON
450 FTS
Mather AFB, CA

On a flight from Clark AB to Christchurch, NZ, you find yourself in a bit of a jam. This time you decided to practice grid navigation but applied precession correction in the wrong direction. As a result, fuel became depleted and a crash landing was made on the north end of a small island. In order to direct rescue aircraft to your position, you must first determine the island you are on. Although the skies are cloudy, you are able to identify and take these three instantaneous observations.

GMT (1 Jan 81)	*HO*	*BODY*
13h 54m 01s	62-00	Procyon
14h 04m 19s	00-02	Upper Limb of Moon
14h 10m	45-04	Canopus

As a result of your precision fixing, a seaplane is sent to fly you to civilization. But, as luck would have it, an island native has stowed away and is now demanding to be flown to his home. With one eye on the shrunken head around the native's neck and the other on the machete in his hand, the pilot decides to follow his directions (apparently he is a locally qualified nav) and a short time later puts down near a small island. Here the native gets out and you are put ashore with your sextant to find out where you've landed. Not wanting to spend any longer than necessary on the island, you take only one observation of the sun. You also notice that the shadow of a large palm tree in front of you passed from right to left across your feet and was its shortest just as you obtained this instantaneous shot.

GMT (1 Jan 81)	*HO*	*BODY*
23h 56m 36s	81-14.5	Sun

With only your Air Almanac and chart, you determine your position and plot a course to safety. Name the two islands and the coordinates to the nearest nautical mile.

	LONGITUDE	*LATITUDE*
Island 1	_____	_____
Island 2	_____	_____

Mail your answer to:

Editor, THE NAVIGATOR Magazine
323 FTW/DOTN
Mather AFB CA 95655

Editor's Note: On 15 June 1981, we will randomly draw two of the correct answers, and the two lucky people will receive a DR kit stowage bag.

The Nav Heritage - The F-89

Lieutenant Colonel Don SOLWOLD
Minnesota ANG/148 TRG
Duluth IAP, MN

I suppose all aviation careers contain a few really memorable events—achievements that set a benchmark from which future events are measured. Perhaps the very first flight, the day wings are pinned on, or the first solo overwater trip qualify as does the initial ride in a new bird.

Now there's another—the day THE NAVIGATOR requests a literary contribution about an outdated air machine, part of our heritage. Now that, let me tell you, approaches real ego travel. It's absolute certification of career maturity. Yes sir, guaranteed membership in the Great WSO Wrinkle-Bank.

So it is in that sense of historical significance the following comments are offered. Not just to a simpler machine, but to a simpler aeronautical era. When unimpaired by TCAs, TRSAs, GCCs, PCAs, IFFs, SIDs, STARs, MTRs, MOAs, and ETCs, the only restriction between takeoff and 30

grand was aircraft limitation (which as I recall was a considerable handicap).

This is a period nostalgically remembered by well-worn WSOs, RIOs, ROs, as the '89 days. It stretched from June 1951, when the first operational Scorpion was assigned to Hamilton AFB and the 84 FIS, until July 1969, when the final "J" number 021896 retired from the Maine Air Guard's 132 FIS.

In all, 1,052 F-89s were produced, becoming an air defense mainstay in the fifties and early sixties. Although never considered the most graceful bird on the ramp, it compiled some pretty impressive statistics. The first truly all-weather interceptor, the F-89 pioneered beam and head-on geometry (detractors will argue that was necessitated by its inability to overtake anything from the stern). It carried the first automatic, computerized fire control system, and was versatile enough to bridge the gap from machine guns through rockets to nukes. It remains today as the only US fighter to ever fire an air-to-air nuclear warhead. That test (John Shot) involved the live firing of an MB-1 (AIR-2A) Genie over Yucca Flat on 19 July 1957. The aircraft involved subsequently was assigned to the Montana Air Guard, and now resides over that unit's entry gate appropriately equipped with a Genie on each pylon.

Originally, the F-89 evolved from growing concern about a potential Soviet bomber threat via the polar route. As early as 1945 the Army Air Force requested design proposals for a conventional propeller driven interceptor that could travel 550 mph, reach 35,000 feet within 12 minutes, and have a combat radius of at least 600 miles. Most proposals, however, included turbojet power plants.

No doubt Northrop's experience producing the World War II P-61 Black Widow enabled it to submit the successful proposal. The first prototype rolled out of their Hawthorne, California plant in mid-1948. It weighed 29,000 pounds, and was powered (perhaps equipped is more accurate) with two Allison engines, each delivering a mere 3,750 pounds of thrust. After being trucked to Muroc Dry Lake for testing, the F-89's first flight occurred in August 1948.

Although underpowered, the bird could never be criticized as underarmed. The A, B, and C series carried 6 20mm cannons, and 16 5-inch rockets. The D model packed 52 2.75-inch rockets in each of its tip pods. They could be fired selectively or in one spectacular blast. By the time the D model debuted in 1954, the engines had grown to a more generous 7,200 pounds thrust. Also, a huge "I" beam was added to beef up the main spar. It was placed right under the RO's seat and subsequently prevented seat height adjustment. An inconvenient but small price since that also

U.S. AIR FORCE
1422
FV-422
USA

FRED HULL

corrected the aircraft's earlier tendency to discard a wing now and then. Eventually, 682 D airframes were delivered making it the most duplicated of all F-89 models. The H model was armed with 21 2.75s and 3 radar-guided Falcon missiles in each tip. As in the D, the aft tip section was devoted to fuel storage. The J carried the ultimate wallop—2 Genies and 4 Falcons. It was never configured with the Falcon option in the field because the demoralizing effect of a nuclear fireball was sufficient to discourage most intruders.

Primarily, the RO's chore was to acquire target contact after a ground controller vectored him into airborne radar range. Like his present day counterpart he would then guide the intercept by radar into a position where the target could be either identified or destroyed. Each of the weapon systems had its own peculiar axis of attack. The early gunslingers required stern geometry to accommodate their shorter cannon ranges. This was essentially the same tactic employed during World War II.

The rocket laden "D" originated a new concept—the beam or right angle approach. This required that RO's modify the original attack geometry to establish a collision course as close to a 90° beam as possible. Once that was accomplished, the pilot pressed the attack with his scope presentation until an on-board computer uncorked as many as 104 rockets. Genie missiles provided an all-aspect capability that allowed the "J" to bore in from any direction. The RO merely determined the nearest collision course and altered heading to that approach angle.

Additionally, the backseater learned about some of the airplane's more remote working parts. Since F-89 numbers were limited, transient maintenance might not be acquainted with its peculiar needs. Six hundred gallons of fuel 30 feet out on each wing motivated most crews to supervise refueling themselves. Generally, to speed things up, the RO handled those duties while his front-seater checked weather and filed.

Since no dual control Scorpions were built, the RO also took on some added instructional tasks. Transition was often accomplished in the operational squadron. New pilots would receive a couple of simulator rides, and be crewed with an instructor RO. The IRO would then assist him from the very first ride until he completed his OJT into the Scorpion guidance and control trade.

Succeeding interceptors (F-101, 102, etc.) received target information via computer generated data link displays. The F-89 did not. It depended on UHF voice commands not only for intercept direction but also for position updates. Maintaining orientation from home base without INS or TACAN became a real challenge after an hour or more of random vectoring at night over frozen Canadian tundra. Although the backseater was charged with navigation responsibilities, limited instrumentation made it strictly a DR exercise. The RO's three nav aids were an altimeter, true airspeed indicator, and compass. Engine instruments were the only gauges in shorter supply. The rear cockpit had none. Mission success depended on the UHF which, like the rest of its avionics, was antiquated but amazingly reliable, expecially considering operating conditions. Because its purpose was to guard against polar intrusions, the F-89 spent its entire life on the blue nose circuit. It patrolled from Alaska to Iceland operating for years from snow covered ramps, apparently invulnerable to the cold weather afflictions of more sensitive systems.

Developing any weapon system poses problems, and the '89 was no exception. Wings, engines and tail feathers all received substantial engineering improvements during its evolution. Intakes barely two feet off the ground provided the image of the world's largest dust mop.

But if it is remembered for its limitations, the F-89 is also recalled for its extremely stable flight characteristics, imposing armament loads, spacious cockpit accommodations, simple reliability and, in a day of 20 million dollar fighters, perhaps also for a fly-away cost of only $988,884.00—with armament.

Lt Col Solwold graduated from the University of Nebraska, Omaha. After completing UNT and RIO at James Connally AFB, he began his flying career in the F-89. Lt Col Solwold now serves with the 148 TRG in the RF-4.

Our centerfold painting depicts an F-89D from the 66 FIS firing a salvo of 2.75-inch rockets at a TM-61 Matador target.

THE NAVIGATOR

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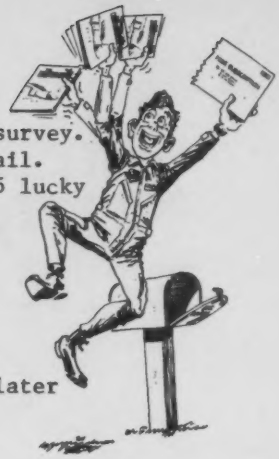

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C-130D Ski-Hercules

Major Raymond F. BESECKER
New York ANG/139 TAS
Schenectady County Airport, NY

The Distant Early Warning (DEW) line stretches from Cape Lisburne, Alaska across Northern Canada to Kulusuk on the east coast of Greenland. Twenty-eight sites provide radar and communications coverage over some of the toughest terrain in the Arctic. They are a vital part of our Early Warning System, and also provide highly valuable navigation assistance to aircraft flying over the polar wilderness.

The need for a ski-equipped airlifter to replace the C-47s for support and resupply of the DEW line dates back to 1956. The Lockheed C-130 Hercules was selected and the last 12 "A" models produced were assigned to this mission. These aircraft were outfitted with arctic equipment consisting of: (1) Dual N-1 compasses, (2) Auxiliary fuel tanks, (3) ATM and battery compartment heat, (4) Larger engine oil tanks, (5) Flight director system, and (6) Skis plus all associated plumbing. The main skis measure 20½ feet by 5½ feet, and the nose ski is 10½ feet by 5½ feet. The added drag reduces cruising speed by 20 knots and range by 9%. The Ski-Herks are C-130Ds and can land with either wheels or skis, whichever conditions warrant.

Flying conditions in the interior of Greenland have been likened to flying in a "bowl of whipped cream" and "inside a ping-pong ball." The weather on the ice cap can change from clear and a million to a complete "white out" in a matter of seconds. These weather changes and conditions present some of the most challenging flying conditions in the world. Full crew coordination and peak performance are needed to complete a safe and successful mission.

The C-130D Arctic DEW line support was handled by the 17 TAS "Firebirds", Elmendorf AFB, Alaska, from 1964 thru 1975. During the summer of 1975, the mission was transferred to the New York Air National Guard (NYANG). The 139 TAS/109 TAG based at Schenectady County Airport received five C-130Ds equipped with skis and six C-130D-6 wheel (non-ski) birds. Thus an active mission was given to the 109 TAG NYANG proving the concept that the Air Guard and Reserves can be a part of the total force.

The 109 TAG, now assigned to the Military Airlift Command (MAC), provides air transportation for personnel, supplies, cargo, fuel, and mail to and from the Distant Early Warning Sites, "DYE 2 and DYE 3", on the Greenland ice cap. In its challenging role, the 109th also provides air transportation for the 139th Aeromedical Evacuation Flight, New York state special support missions, and other Arctic operations directed by the Air Force, MAC, the Air National Guard, and New York state. In addition, the 109th is also responsible for emergency response capabilities in the Arctic and other operations worldwide.

The typical DEW line support mission starts with deployment from Schenectady County Airport, New York and a six-hour flight up over Northeastern Canada to Sondrestrom Air Base, Greenland. Lonely and desolate, Sondrestrom AB is located just above the Arctic Circle 15 miles from the southwestern edge of the Greenland ice cap at the end of a 100 mile-long fjord. Approaches to the single runway (11/29) are aligned with the fjord; 2,000 foot terrain rises along both sides of the final approach course.

Due to terrain, all instrument approaches are conducted to runway 11; visual or circling approaches are available to runway 29. ASR, NDB and TACAN approaches require up to four miles visibility. A go-around from an approach to runway 11 calls for extreme caution, again due to high terrain on three sides of the field.

Another hazard associated with Sondrestrom is runway illusion. The first 3,500 feet of runway 11,

which is 9,200 feet long, has a 1.5 percent upslope. At touchdown, a pilot might get the impression that the crest of the runway is actually the end, instead of another mile down the centerline.

Sondrestrom's mission is primarily to provide logistic support for the two radar sites located on the ice cap. These "DYE" sites are supported by ski-equipped C-130D aircraft. Every gallon of fuel used by these sites is delivered by C-130Ds. DYE 2 is located 100 nm east of Sondrestrom atop the ice cap which is 7,600 feet above sea level. DYE 3 is 200 nm southeast of Sondrestrom and sits 8,700 feet upon the ice cap. The only access to these sites is by air. The deep crevices near the edge of the ice cap prevent any possibility of transporting cargo over the ice.

All navigators of the 139 TAS/109 TAG must maintain grid currency. Besides regular annual navigational check rides, ice cap airborne radar approaches and procedural check rides are given. In places like the frozen wastes of the Arctic where navigational aids are primitive or nonexistent, the APN-59 radar has been a lifesaver. One phenomenon of radar use in the Arctic regions is that bodies of water, rather than land, will show on the radar scope (Arctic reversal).

On a typical mission to the interior of the ice cap, the navigator directs the aircraft from Sondrestrom to either of the DYE sites using DR, radar and Omega. The DYE site normally will show on the radar scope 80 to 90 miles out. Radio contact is made with the DYE site as soon as possible and the latest altimeter, winds, and weather conditions are obtained. The winds are given in true, and +40° variation must be applied to get the mag direction.

Aircraft do not descend below the minimum enroute altitude until within 25 nm of the landing zone. At 25 nm, descent may be made to the minimum safe altitude as depicted on the Airborne Radar Approach (ARA) plate. At 10 nm, descent may be made to pattern altitude. When initiating a descent, the radar altimeter (APN22) will be set on 1,000 feet. As soon as landing minimums are established, it will be reset to minimums. Under IFR conditions the altimeter readings, with current station altimeter setting, will be cross-checked against absolute altimeter readings (APN22 and SCR-718) before descending below pattern altitude. The Dash One and navigational manuals have a warning stating that the SCR-718 may not be accurate over large fields of snow and ice, but our experience on the Greenland cap has shown it to be quite reliable; probably due to the compactness of the ice.

The skiways at the sites are approximately 6,000 feet long by 150 feet wide. They are marked

by radar reflective flags mounted on bamboo poles four feet high. There are run-in flags, threshold flags and skiway flags. A landing will not be attempted unless at least three sets of runway flags are visible. Landings aren't made on the ice cap when the maximum wind, including gusts, exceeds 35 knots.

The navigator must direct the aircraft over the skiway, cross-checking the absolute altimeter to extablish the minimums for the final run in. The Doppler is set on the skiway heading with drop position selected so that accurate distance and cross track can be monitored during the box pattern. A five by ten mile box pattern is flown. Checking and resetting the radar heading marker with the pilot's heading reference is very important, for a difference of one degree could mean a missed approach. The "prepare to begin descent" warning is given at 7½ nm from the end of the skiway, and descent begins at 6½ nm. A minimum descent rate of 300-310 feet/min is required.

Heading and altitude corrections are given at least each mile. If visual contact is not made with the lead-in flags at 9,000 feet MSL (minimum altitude), the descent is discontinued and altitude is maintained. If visual contact is not made at one mile, a missed approach is executed. A good navigator can give a pilot as good a precision approach as a Ground Controlled Approach (GCA). It is not uncommon to make 3 or 4 approaches at a DYE site and encounter 3 or 4 different types of weather conditions all within 30 minutes.

Open snow takeoff and landing at the DYE sites may be conducted when the landing zone crosswind component exceeds 15 knots or landing zone conditions dictate. The navigator sets up a pattern into the wind with planned touchdown on the side of the skiway near the DYE site. Open snow operations in remote areas away from the DYE sites call for a second aircraft to fly top cover and maintain radio contact with the staging base and landing aircraft.

This may be the only mission in which the navigator gets to navigate on the surface as well as in the air. On a recent ice cap mission, an open snow landing was made in a remote area in support of a National Science Foundation Team. When the takeoff was attempted, a max speed of only 35 knots could be obtained. This was due to the soft sticky snow conditions, the higher than usual temperature, the high altitude, and the weight of the cargo. After 17 attempted takeoffs, the navigator gave a heading back to DYE 3 site for a ground run over the snow. The aircraft arrived 2½ hours later after a 40-mile taxi. (Probably a world's record).

Apart from the springtime fuel airlift and the heavy equipment delivered to the DYE sites, the 109 TAG also supports, on an irregular basis, several of the DEW line sites in the northwest territory of Canada. The rest of the time is taken by flying training and airlift missions, and hauling cargo all over the United States, Europe, Hawaii, and the Caribbean. The men and women of the 139 TAS/109 TAG are truly proud of the C-130D Ski-Herk and the mission it plays in our country's role of airlift and support.

Commissioned through OCS in 1962, Maj Besecker completed UNT at James Connally AFB in 1963. He served as a navigator instructor and was assigned to the C-130. Employed by the General Electric Co., Maj Besecker presently flies with the 139 TAS, NY ANG.

SAM Navigator

Captain William H. CONRAD
1 MAS
Andrews AFB, MD

"Pilot, Nav. We are 125 miles out of Paris now. We're running about 4 minutes and 30 seconds behind our block time. Let's delay our descent another 30 miles."

"Okay, Nav. I can pick up about 3 minutes in the descent, so that'll still put us about 1½ minutes late."

"That should work out fine. If we can plan on making the high speed taxiway, then a 180 to the parallel, we can cut 90 seconds off our taxi time."

After a smooth touchdown 15 minutes later, the sleek VC-137 rolls down the runway, gradually braking to taxi speed.

"Pilot, Nav. Block time in 3½ minutes. We have about 6,000 feet to taxi. I figure a 22 knot taxi speed will do it. I'm showing 17 knots on the INS."

"Okay, Nav, I see the band and the limousines. Looks like they're ready for us. Have the stewards stand by on the doors."

The silver-and-white airliner approaches the waiting group of dignitaries. The crew had informed the U.S. embassy in Paris a month ago that the arrival time would be 9:00 am. The time is 8:59 and 30 seconds.

"Pilot, Nav, 30 seconds remaining. Make it a slow turn ...15 seconds ...5 seconds ...Hack!"

As the plane eases to a stop, the 10-foot steps roll to the side of the fuselage, the doors open, the VIP steps out, the Honor Guard salutes and the band plays.

The crew can relax a little now. Another mission has been completed in the tradition of the 89th Military Airlift Group. The mission of the 89th is to provide safe, comfortable and reliable air transportation around the globe to the President, Vice-President, and other high-ranking officials, both national and international. The 89th is the Air Force's Special Air Missions (SAM) group and it has provided this service for the past 32 years with a record unmatched by any other organization. No accidents have occurred, and the on-time departure reliability record is in the neighborhood of 99.5%. SAM arrivals are usually within seconds of the published "block time."

This precise arrival time is no coincidence. It results only after weeks, sometimes months, of intensive planning and coordination—much of it done by the SAM navigator. Let's look at a typical SAM mission from the perspective of a navigator in the 1st Military Airlift Squadron, the principal fixed wing flying unit of the 89th.

The SAM navigator's job begins when a mission itinerary comes down from the Vice Chief of Staff, USAF, Office for Special Air Missions. The navigator then becomes the primary mission planner. The work begins by selecting the routes the aircraft will fly. Using the USAF Foreign Clearance Guide, the navigator then determines the countries that require special diplomatic clearances for overflight or landing. Since many SAM missions enter communist-bloc countries, obtaining overflight clearance can be complicated. Clearances are obtained from the government of the country involved through the U.S. Embassy in that country or the Department of State.

Using the library of information available in the 89th Military Airlift Group's Navigation and Briefing Section, the SAM navigator will gather a great deal of information on each airfield along the route. Runway weight-bearing restrictions, parking locations, taxi diagrams, ground servicing equipment availability and airfield security are but a few of the researched items. In addition, the navigator will help locate a suitable hotel and ground transportation for the crew. Other tasks include checking the Flight Planning Document for preferred routes or special restrictions, and the Jeppeson Flight Planning Books for information about airfields not commonly used by military aircraft. The navigator will then compute the performance of the aircraft and fuel requirements.

With this data at hand, a teletype message is drafted and sent to the embassies, support agencies and command posts along the route. This message coordinates the myriad of support

requirements involved with the arrival of a dignitary. Communications between the crew navigator and the support agencies downstream are essential to well-coordinated events on the day of arrival.

After the initial messages have been sent, the SAM nav begins the detailed route planning. A manual flight plan for each leg of the route is spun, for a flight plan must be available should the computer flight plan not arrive. ICAO International flight plans, Passenger Information Cards, and VIP maps will be completed before the mission departs. As a part of the preliminary work, the SAM navigator will plan all approaches to the nearest second. Approach time can be accurately computed, in most cases, if a Standard Terminal Arrival (STAR) is used. Research and experience will determine what approach to expect and where delays can be anticipated. Once the approach track is determined, the exact approach time can be computed using a "descent profile graph" developed specifically for 89th missions. The navigator has to allow extra time for landing at high density airports during peak traffic periods. Experience will dictate how much.

Since most of the planning has been done weeks in advance, duties on the day of departure are fairly straightforward. Two hours before departure time the pilots and navigators will meet at Base Operations, or the civilian equivalent, for the routine weather checks, NOTAMS and filing the flight plan. The SAM navigator will have completed the DD Form 1801, International Flight Plan, long before the arrival of the pilots.

The crew will be ready to depart one-half hour early in case the party arrives early. The aircraft commander awaits the arrival of the party at the top of the aircraft steps, while the copilot sits in the right seat and runs the checklists. The radio operators preflight the nav gear, and can repair all nav equipment if necessary. When the VIP enters the aircraft, the engineer and copilot start the engines. By this time, the door is secured and the aircraft is ready to taxi. The aircraft commander jumps in the left seat and the aircraft moves forward only seconds after the passengers are aboard.

Even before takeoff, the SAM navigator is busy computing the block time. Tasks include adjusting for unexpected winds, late arrival of the party, or runway changes if necessary. With this in mind, the SAM navigator will select an airspeed to insure a timely arrival. Enroute the nav can "fly" the aircraft, since the autopilot can be coupled to the INS. Course guidance is routine and the navigator spends much time working timing problems.

After landing, the navigator must arrange for the next day's weather briefing and computer flight plans with local support personnel. Then, a kit of publications (FLIP, charts, flight manuals, approach plates, etc.) is packed to take to the hotel room. From the hotel room, the nav must be ready to flight plan to any location, should the party decide to change the itinerary. Communications with support agencies, usually through embassy channels, insure that arrangements made prior to the mission are going smoothly. One must be prepared to handle any problems that arise on the next leg.

Perhaps what really sets this job apart is the spirit of "SAM FOX." This term dates back to the earliest history of VIP flights, when any flight carrying a VIP used a call sign consisting of the tail number and the prefix "Special Flight." The phonetic alphabet in use at that time used "SAM" to designate "S" and "FOX" for the letter "F." Thus, the Independence, carrying President Truman, would use the call sign "SAM FOX 6505." The attention to detail and thorough approach employed by everyone concerned became known as "SAM FOX," a tradition that is still maintained today. "SAM FOX" means that one does everything associated with SAM missions as accurately and thoroughly as humanly possible. It means keeping the aircraft spotlessly clean and shiny inside and out. It means that every action while on a trip is directed toward the priorities of safety, comfort and timeliness. SAM FOX is a fresh haircut and a neat appearance.

Sound like your cup of tea? Where do I sign up? The 89th has openings for 5-7 new navs per year. You need to be an instructor or flight examiner with at least 2,000 hours flying time. Further requirements are listed in AFR 36-20, Chapter 8. If you are interested, an AF Form 90 will get the ball rolling. Applicants usually are flown TDY to Andrews AFB for interviews.

Being a SAM navigator is an exciting and demanding job, but if you ask any SAM nav, I'm sure he will tell you "It's the best job in the Air Force!"

Capt Conrad graduated from the University of Florida in 1972. After UNT, he was assigned to the C-130 at Little Rock AFB. In 1975, he obtained a master's degree in Operations Management from the University of Arkansas. Capt Conrad now is assigned to the C-135/C-137 at Andrews AFB.

NAVSTAR GPS

Mr Leonard J. JACOBSON
Mr Michael A. BITTNER
Magnavox Corporation
Torrance, CA

The technology of navigation on earth has come a long way from the early use of astrolabes and the study of celestial patterns. With the deployment of the NAVSTAR Global Positioning System (GPS), we will be able to fix the position of anyone, anywhere on earth, with unprecedented accuracy.

The NAVSTAR GPS is a space-based radio positioning and navigation system that provides 10 meter accuracy of three-dimensional position data, velocity information, and system time to suitably equipped military users anywhere on or near the earth. The GPS testing and development is currently under a joint program managed by the USAF Space Division at El Segundo, California. Deputy program managers from the Army, Navy, Marine Corps, Department of Transportation, Defense Mapping, and NATO are assigned to the Joint Program Office.

HOW DOES IT WORK?

The GPS consists of three major system segments: space, control, and user (see Figure 1). The operational space system segment deploys several planes of satellites in circular 10,898 nautical mile orbits, resulting in a 12-hour period. With 18 satellites, coverage is provided for continuous three-dimensional position, navigation and velocity determination. Each satellite transmits a composite signal at two L-band frequencies consisting of a precision (P) and a coarse/acquisition (C/A) navigation signal. These signals contain satellite ephemerides, atmospheric propagation correction data, and satellite clock bias information provided by a master station. In addition, the second L-band navigation signal permits the user to correct for the ionospheric group delay or other electromagnetic disturbances in the atmosphere.

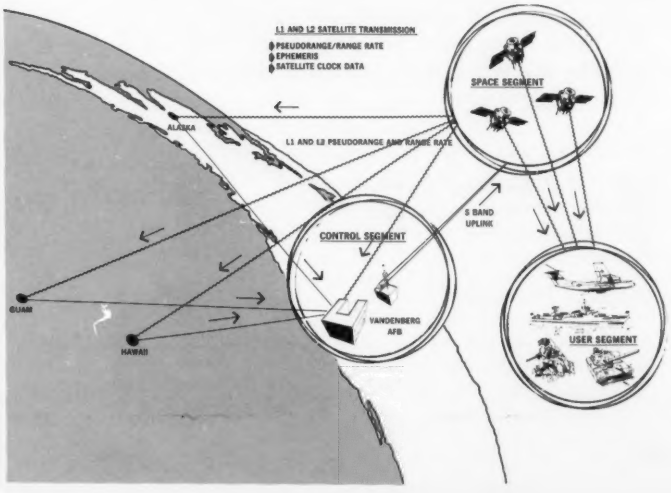


Figure 1. NAVSTAR GPS Segments

In the current control system segment, four widely separated monitor stations, located on U.S. controlled territory, passively track all satellites in view and accumulate ranging data from the navigation signals. The ranging information is processed at a master control station at Vandenberg AFB, California and used in satellite orbit determination and systematic error elimination.

The orbit determination process derives progressively refined information defining the gravitational field influencing spacecraft motion, solar pressure parameters, location, clock drifts, electronic delay characteristics of the ground stations, and other observable system influences. An upload station located in the continental United States transmits the satellite ephemerides, clock drifts, and propagation delay data to the satellites as required.

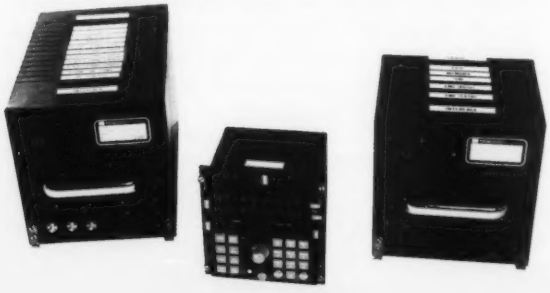
Each of the satellites emits a carrier which is modulated with a pseudorandom noise code of very low repetition rate. The code generation is synchronized to the satellite clock time reference. The user receiver also maintains a time reference to generate a replica of the code transmitted by the satellite. The amount of time skew that the receiver must apply to correlate the replica with the code received from the satellite provides a measure of the signal propagation time between the satellite and the receiver. This time of

propagation is called the pseudorange measurement since it is in error by the amount of time synchronization between the satellite and receiver clocks. The receiver also measures the Doppler shift of the carrier signals from the satellite. By measuring the accumulated phase difference in this Doppler signal over a fixed interval, the receiver can infer the range change increment. This measurement is called the delta pseudorange measurement, and is in error by an amount proportional to the relative frequency error between the emitter and receiver clocks. Since the carrier wavelength is short, the delta pseudorange is a finely quantized measurement.

Measurements from four satellites provide the receiver with sufficient information to solve for three components of user position, velocity, and clock errors. To accomplish the navigation function, pseudorange and delta pseudorange measurements are used to update a running estimate of position.

USER EQUIPMENT

This segment is the result of the other two segments. Between 1975 and 1979, tests of advanced development models aboard aircraft, ships, land vehicles and helicopters validated the GPS concept with navigation to 10-meter accuracy and weapons delivery from an F-4 aircraft to never-before-achieved CEPs for "dumb" (ballistic) bombs. Refueling rendezvous, cross country navigation, static positioning, coordinated ASW operations, etc., were all demonstrated at the Yuma, Arizona test range and on the ocean. Nonprecision approaches were demonstrated within the standard ILS window. Current aircraft user equipment under development consists of a simple, single element conformal antenna; however, high anti-jam, null steering antennas are also available. Figure 2 shows the receiver/processor, control/display and interface for current high performance fighters and bombers.



NAVIGATING WITH GPS

From the pilot or navigator point of view, operating a GPS set is essentially the same as operating an inertial system. There is no drift, however, and the latitude/longitude readout resolution is down to one-tenth of a second. Furthermore, the system is three dimensional. Altitude of the aircraft may be read out and altitude as well as coordinate data may be entered for waypoints. By entering desired vertical path angle to the selected waypoint along with desired track from the aircraft's Horizonal Situation Indicator, vertical navigation can be accomplished, including synthetic glideslope tracking.

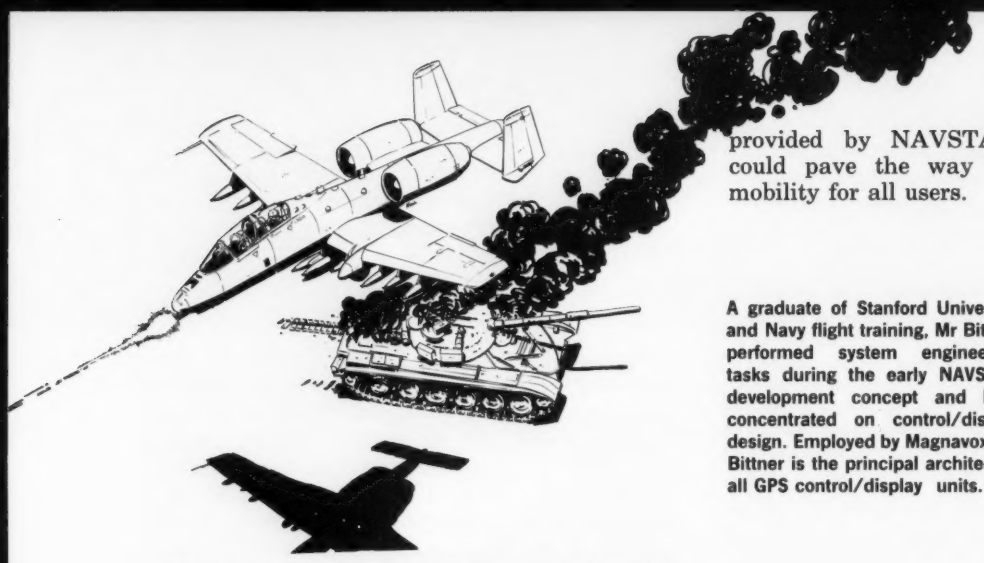
The standard 3-D area navigation parameters are available for digital display including distance, bearing, cross track error, track angle error, vertical error, vertical angle, automatically computed magnetic variation, time-to-go, and GMT accurate to a nanosecond (one billionth of a second—should be accurate enough for most needs!). In addition, the three vectors of the wind triangle plus drift angle can be read out.

No GPS peculiar operations are required of a navigator so that existing control/display units can be used. The basic operation is to turn on the set and observe it sequence from warm-up through acquisition to navigate mode, select a waypoint and desired track, and then just follow the needles. Moving waypoints with start times and velocity can also be entered by the navigator. This capability allows homing on and tracking these waypoints in four dimensions (3-D plus speed-up/slow-down command) to allow completely passive, all-weather rendezvous. GPS can easily bring a fighter within the wingspan of a tanker by this method without either aircraft having to radiate signals detectable by an enemy.

SYSTEM APPLICATIONS

The possibilities of GPS are almost endless for every branch of the military. Potential Army missions include quick positioning of mobile artillery, surveys, tie-in of fire lines, and working with the Air Force and Navy during joint exercises.

Figure 2. Multi-channel Receiver/Processor Unit, Control Display Unit and Flexible Modular Interface Unit



provided by NAVSTAR's man-made "stars" could pave the way to increased and safer mobility for all users.

A graduate of Stanford University and Navy flight training, Mr Bittner performed system engineering tasks during the early NAVSTAR development concept and later concentrated on control/display design. Employed by Magnavox, Mr Bittner is the principal architect of all GPS control/display units.

Naval applications include antisubmarine warfare and harbor control, including buoy, shoal, reef location, and navigating mine fields. The GPS could provide accurate close air support for the Army and could be used in reconnaissance as well as approach and landing to unaided airfields. The system could also aid in dropping supplies and troops. By the end of 1987, the constellation will be complete, allowing worldwide three-dimensional navigation.

Indeed, the NAVSTAR Global Positioning System is a far cry from the direction provided by Orion and the North Star. The information

Mr Jacobson has a master's degree in Electrical Engineering from the Polytechnic Institute, Brooklyn. He has been employed at ITT World Communications, NY and at Hughes Aircraft Co., CA. Since 1968, Mr Jacobson has held various engineering and marketing positions at Magnavox and is now Director of Marketing for GPS.

COMPUTER FLIGHT PLANNING

Captain Titus PURDIN
314 TAW/DOA
Little Rock AFB, AR

The article by Captains Hoffsommer and Gambrell (summer 1980) highlighted an important trend in the art and science of navigation. General purpose computing power for navigation uses will continue to increase. For some time to come we will be creating, evaluating, and refining new applications for these computers. This article covers flight planning as one such application.

Producing a flight plan, fundamental to the navigation process, is ideally suited to computer generation. This has been recognized for some time in the high altitude flight plans available through global weather central. Advantages may be realized, however, by making these flight plans more available, more timely, or more specialized. Producing low altitude tactical flight plans for C-130 airdrop missions is an example. Local

computing power can provide tactical flight planning facilities where mission requirements have made traditional computer-generated flight plans impractical.

The flight planning system in this article was written in 1975 and used first at Clark AB, Philippines. Today it exists in several computer languages. Like all such systems, it has evolved towards its present purpose. For the sake of speed, convenience or simplicity, we have decided to follow certain procedures. If the specific purpose of this system were different (or were to change), it might be profitable to change some of those decisions.

This system consists of three primary programs and a number of smaller system maintenance programs. The three main programs are an input parameter (called FLTPLAN), a low level flight plan generator (called LOWLEVEL), and a Computed Air Release Point solution (called CARPCOMP). The ancillary programs provide facilities for creating, monitoring, and updating the stored routes associated with the system.

The FLTPLAN program queries the user for a long list of input parameters (see Figure 1). Note that virtually all of these requested parameters may be omitted—the program requests, not demands, them. In every case, omitted parameters will be supplied by the program either from a list of assumptions or from a "best guess" based on other inputs. The input parameters are written forward for use by later programs in a temporary data file. The last three input parameters are used by the FLTPLAN program to determine precisely which other programs are to be run.

```
RUN

ROUTE DESIG:  01
YY.MM.DD:  80.08.29
TEMP:  22
ALTITUDE W.V:  120.24
EXTRA W.V:  110.20
CLIMB W.V:  90.11
DROP W.V:  85.8
ALTIMETER:  29.92
TOA: 1200
TYPE: CDS
WEIGHT: 1608
SKE?
NAV'S NAME:  Titus Purdin
'CRT' OR 'PRT'? PRT
NEXT? (LOWLEVEL/CARPCOMP/STOP):  LOWLEVEL
AFTER LOWLEVEL? (CARPCOMP/FLTPLAN/STOP):  CARPCOMP
AFTER CARPCOMP? (FLTPLAN/STOP):  STOP
```

Figure 1

The LOWLEVEL program produces a two-page low altitude flight plan (see Figure 2). The first page represents a traditional flight plan. Using the input parameters, winds and temperatures are applied to stored airspeeds and courses to arrive at true airspeeds and magnetic headings. The second page provides special data which is useful to navigators on low altitude C-130 airdrop missions. This includes leg distances, radio aids, obstructions along each leg, and ETAs to turn points in tenths of minutes. The information between the asterisks is data needed for entry into the ASN 35 Doppler Computer. In general, this information represents the data necessary for the navigators' turn point briefings.

```
LOW LEVEL FLIGHT PLAN                                          DATE: 29 AUG 80
ALL AMERICAN DROP ZONE
ROUTE 9/FROM KLRF RUNWAY 25/DAY ALT                            TOA: 1200
NAVIGATOR: Titus Purdin
PILOT:
AIRCRAFT: C-130     NUMBER:
FORMATION POSITION:

    TO        TMP  IAS   WD/V    GRD   LEG  ACCM  TRU  VAR  MAG  DFT  MAG
              ALT  TAS          SPD   TIME TIME  CRS       CRS  COR  HDG
34-51.2N      21   180
92-23.2W      2.5  190   090/11  197   4.0  4.0   252  -6   246  -1   245
ACCELER-      21   180
   ATION      2.5  190   120/24  212   2.0  6.7   337  -6   331  4    335
35-03.9N      21   210
92-31.3W      2.5  222   120/24  241   1.9  8.6   337  -6   331  3    334
35-19.5N      21   210
92-20.4W      2.5  222   120/24  218   5.1  13.7  044  -6   038  6    044
35-33.6N      24   210
92-22.6W      1.0  217   120/24  232   3.6  17.3  351  -6   345  4    349
35-57.9N      23   210
92-06.2W      1.5  218   120/24  218   7.7  25.0  032  -6   026  6    032
36-47.0N      24   210
91-25.0W      1.0  217   110/20  217   10.0 35.0  111  -6   105  0    105
35-22.5N      20   210
91-23.3W      3.0  224   110/20  214   6.9  41.8  181  -6   175  -5   170
34-59.2N      20   210
91-44.3W      3.0  224   110/20  227   7.8  49.6  218  -6   212  -5   207
34-57.1N      20   210
92-01.2W      3.0  224   110/20  243   3.5  53.1  265  -6   259  -3   256
SLOWDOWN      20   210
              3.0  224   110/20  241   1.5  54.6  262  -6   256  -3   253
34-54.9N      24   125
92-18.3W      1.0  129   090/11  138   3.6  57.7  262  -6   256  -1   255
```

Figure 2A

```
WORKSHEET
ROUTE 9/FROM KLRF RUNWAY 25/DAY ALT                            TOA: 1200


STATIONS: 1030    TAXI: 1045    20 MIN: 1140    6 MIN: 1154

ENG START: 1035   T/OFF: 1102   10 MIN: 1150    1 MIN: 1159

  TURN PT    ALT   LEG   HIGH      *MAG    DOPPLER  *   ETA      NOTES
             DIST  OBST    *CRS    DIST  X/TR=    ATA
LRF 245/12                1140'   *                *  1106.3
           2.5M  13.0  TOWER   *246    12.0  0.0R*
ACCELERATE                        *                *  1109
           2.5M  7.2             *331    14.5  1.1R*
LRF 290/20                1140'   *                *  1110.9
           2.5M  7.5   TOWER   *331                 *
LRF 336/26                817'    *                *  1116
BENNETTS XTN 2.5M 18.7  TERRAIN *038    18.4  1.0R*
LRF 339/40                1150'   *                *  1119.6
PT GREER LK  .5A  14.0  TERRAIN *345    14.3  1.0L*
ARG 256/57                1650'   *                *  1127.3
ROAD BEND    .5A  27.9  TERRAIN *026    27.7  0.6R*
ARG 224/30                1050'   *                *  1137.3
ROAD BRIDGE  .5A  36.0  TERRAIN *105    35.2  1.5R*
LRF 048/47                750'    *                *  1144.1
RIVER BEND   3.0M 24.5  TERRAIN *175    24.1  1.1R*
LRF 074/22                250'    *                *  1151.9
HICKORY PLN  3.0M 29.4  TERRAIN *212    29.2  0.5R*
LRF 066/07                250'    *                *  1153.4
TYV LAKE     3.0M 14.1  TERRAIN *259    13.9  0.6R*
SAC RMP/VIS               521'    *                *  1156.9
2 DME/SKE    3.0M  6.0   TOWER   *256    14.3  0.0R*
ALL AMER                          *                *  1200
DROP ZONE    1.0M  8.3            *256             *
```

Figure 2B

The CARPCOMP program calculates a Computed Air Release Point for the specified airdrop load and prints a formated AF Form 512 (see Figure 3). The airspeed and wind calculations are accomplished the same as in the LOWLEVEL program. The parachute ballistic data used in the CARP calculations are taken from straight line approximations over short distances of the ballistic curves in AFM 51-40. From a practical point of view, this has proven to be quite accurate.

This system has been designed to run from "canned" routes. This is satisfactory in a stable flying environment, but certainly wouldn't be in a

```
CARP COMPUTATIONS                                    29 AUG 80

DROP ZONE: ALL AMERICAN E-W                          TOA: 1200
NAVIGATOR: Titus Purdin
PILOT:                          ALTIMETER: 29.92


01 DROP ALTITUDE          500
02 TERRAIN ELEVATION      400              LIVE CDS
03 TRUE ALTITUDE         1000               ONE G12D
04 PRESSURE ALT VAR         0              1608 LBS
05 PRESSURE ALTITUDE     1000
06 CORR DROP ALTITUDE     585              CARP FALLS
07 TERRAIN ELEVATION      400              580 SHORT
08 INDICATED ALTITUDE     985                9 LEFT
                         -----
09 TEMPERATURE             29
10 INDICATED AIRSPEED     130   1-ALL AMERICAN E-W DROP ZONE IS
11 TRUE AIRSPEED          135     LOCATED AT LRF 260/7.5
12 RATE OF FALL          23.3   2-DZ IS 1800 YDS LONG AND 900 YDS
13 ADJ RATE OF FALL      24.0     WIDE.
14 ALT ABOVE IMPACT PT    640   3-STOP WATCH DISTANCE IS FROM
15 VERTICAL DISTANCE      495     TIMING LIGHTS.
16 STABLE ALTITUDE        145   4-PRIMARY JETTISON AREA IS LOCATED
17 TIME OF FALL           6.0     AT LRF 273/7.
18 TIME OF FALL CONSTANT  7.0   5-THIS FORM SUBMITTED IN LIEU OF
19 TOTAL TIME OF FALL    13.0     MAC FORM 512.
20 BALLISTIC WIND         085
      VELOCITY              8
21 DRIFT EFFECT (FOR SKT)  37
22 DROP ALTITUDE WIND     090     RECORDED DATA
      VELOCITY             11             -SURFACE WIND
23 MAG COURSE             256             -MEAN EFFECTIVE WIND
24 DRIFT CORRECTION        -1             -ALTITUDE WIND
25 MAG HEADING            255     DROP DATA
                         -----            -BALLISTIC WIND (M/I)
26 GROUND SPEED           145             -GROUND SPEED (C/D/S)
27 EXIT TIME              6.4             -DRIFT (C/D/S)
28 DECEL QUOTIENT          .0             -GREEN LIGHT TIME
29 FORWARD TRAVEL TIME    6.4             -RED LIGHT TIME
30 FORWARD TRAVEL DIST    523     RESULTS
31 USABLE DZ LENGTH       900             -TOT
32 USABLE DZ TIME        10.0             -FORMATION POSITION
33 STOP WATCH DISTANCE    195             -RAW CIRCULAR ERROR
34 STOP WATCH TIME        2.4             -CORRECTED CIRCULAR ERROR
35 RED LIGHT TIME        12.4     NAVIGATOR'S SIGNATURE
```

Figure 3

TRUE AIR SPEED =

indicated air speed *(.971+temp*((.017+INT (altitude/50.1)*.002)/10)+altitude/10*(.02+INT(altitude/50.1 .00035)))

Figure 4

constantly changing tactical situation. The airspeed calculation, as currently accomplished, (see Figure 4) is accurate only in the envelope from sea level to 9000 MSL. For a more complex profile, such as high/low altitude, a more rigorous airspeed calculation (see THE NAVIGATOR, Winter 1977) would have to be substituted. Similarly, the principles of spherical trigonometry can be used to allow point-to-point calculations of courses and distances, thus making the creation and maintenance of routes much easier and, consequently, more responsive. The important thing in this last discussion is the flexibility of the computer and its ability to accommodate a flight planning system with many configurations. Notice that the same computer can run the Hoffsommer-Gambrell celestial trainer. With the advent of such computer systems, applications for navigators are unlimited.

Commissioned through AECP, Capt Purdin graduated from Ohio State University in 1969. After a tour with USAFSS, in 1972 he completed UNT before assignment to the C-130 at Clark AB. In 1980, he earned a BS in Computer Science from the University of Arkansas. Capt Purdin is an instructor navigator with the 314 TAW, Little Rock AFB.

NAVIGRAMS

(Continued From Page 13)

The Silver Wings Aviation Museum at Mather AFB is building a collection of Navigator Training class patches. At present, about 50 patches have been donated, and the goal is to obtain a patch from every nav class at Mather, Connally and Harlingen AFBs. The Museum operates on a limited budget, and the donation of your patch would be appreciated. The first patch received from each class will be displayed with the doner's name. Duplicates will be quickly returned. Please send the patches to: Silver Wings Aviation Museum, 323 FTW/DOTN (Stop 16), Mather AFB, CA 95655, ATTN: Maj Hetrick.

THE LARGEST GATHERING OF NAVIGATOR GENERAL OFFICERS

On 6 February 1981, Mather AFB hosted project NAVSTAR, a dining-in featuring the largest gathering of navigator general officers ever assembled. Pictured above, left to right, are: Brigadier Generals James W. Taylor (USAFR), Winston D. Powers, Attilio Pedroli, Keith D. McCartney, and Bernard P. Randolph; Lieutenant General Gerald J. Post; Brigadier Generals Raymond C. Preston, Jr., Titus C. Hall, and Donald W. Goodman.

HOW TO SUBMIT AN ARTICLE FOR THE NAVIGATOR MAGAZINE

Most of the material published in THE NAVIGATOR has been voluntarily contributed by navigators throughout the Air Force. Why not do your part toward advancing the profession? Make your ideas and experiences available to your fellow navigators by submitting them for worldwide publication in THE NAVIGATOR.

SUBJECTS: Any article relating to air navigation or the navigator career field is appropriate; therefore, an almost infinite variety of subjects is available. The choice, of course, will depend upon your particular interests. Here are some general areas to consider:

1. Informative operational experiences.
2. Improved procedures, techniques, and equipment.
3. New or proposed navigational concepts and equipment.
4. Analytical suggestions to improve the career field.

Articles should not be reprints, material readily accessible to Air Force navigators, or verbatim restatements of AFRs, AFMs, TOs, etc. Of course, classified information cannot be used.

REVIEW AND CLEARANCE: The article *must* be formally cleared for publication. This can best be accomplished through your base Public Affairs Office, who will insure that your manuscript is properly reviewed and cleared prior to release. SAC personnel should refer to SACR 5-3 for article submission procedures. Provide THE NAVIGATOR with a copy of the clearance letter attached to your manuscript.

FORMAT: Your manuscript may be prose, poetry, or cartoon with a narrative and/or technical writing style. Articles should be typed, double spaced and include a suggested title and the author's grade, name, and organizational address. Only one copy is required. Include a short biographical sketch and photograph of the author in Class A uniform.

SUPPORTIVE MATERIAL: The old saying about a picture being worth 1,000 words still applies. Carefully consider whether your manuscript would be enhanced by illustrative material. Diagrams, charts, photographs (preferably glossy black and whites), etc, are often the key to putting an idea across.

Put your improvement, innovation, humorous comment, or career-related suggestion down on paper and send it along. Our address is:

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Naval Flight Officer on P-3 Orions

Lieutenant Stephen A. LUHRMAN, USN
Naval Air Training Unit
Mather AFB, CA

As a newly commissioned ensign in the United States Navy, I had always believed a "TACCO" was a tasty Mexican dish. Little did I realize that two years later my aspirations of becoming a TACCO would be met as a P-3 Orion crew member.

As in all military aircraft, the training received fulfills the mission of the particular aircraft. The primary mission of the P-3 is submarine hunting, or antisubmarine warfare. For this mission the P-3 carries a variety of sensors to detect, locate and destroy submarines. These sensors include acoustic devices, and nonacoustic sensors, e.g., radar, magnetic detection sensors, electronic emission sensors, infrared cameras, and visual capabilities. Acoustic capabilities are accomplished by strategically deploying buoys with microphones, called hydrophones, which transmit submarine machinery noise to the P-3 electronic processors, where the enlisted crew members interpret data into usable information for the Tactical Coordinator (TACCO).

Obviously, a P-3 performs many jobs, has a lot of equipment, and operates with a crew of 12. Who on the P-3 could manage these sensors and the weapon systems? The pilot and copilot are too busy driving the "bus", yanking and banking to stay on top of a submarine. The navigator is busy determining position through all of these turns, altitude and speed changes. Who on the P-3 will take charge when a 20-year seasoned fleet submarine skipper maneuvers evasively in excess of 30 knots so that a weapon can be placed on top of him? The answer—a TACCO.

The Tactical Coordinator is a Naval flight officer who has proven he is an exceptional P-3 navigator with the systems and tactical knowledge, aggressiveness, tenacity, and alacrity to manage a 35 million-dollar-plus aircraft, 5 officers and 7 enlisted crew members.

As a P-3 maritime navigator, this coveted goal of becoming a TACCO requires considerable hard work. But then, a lot of work is required to become a proficient P-3 navigator as well. The P-3 comes in several models today, but the most common Orion is the P-3C. The navigator aboard a P-3C has many navigational systems to aid him in his job: a navigational computer that prints out a current log line on request, 2 inertial navigational systems, a Loran or Omega set, Doppler nav, radar system with an enlisted radar operator, sextant, and airways navigational systems (TACAN, VOR, ADF). All these help the P-3C nav keep accurate positional information, even in a maneuvering platform. In addition to performing traditional navigation duties, the P-3 nav has been given the responsibility of sending and monitoring communications. Communications include a sophisticated data link net, HF voice and teletype, and UHF secure and unsecure communications.

Once a P-3 navigator has an intimate knowledge of the navigational systems, he studies the remainder of the Orion systems so he can "fleet up" to TACCO. Sensor operator systems, power plant systems, weapon systems, and computer interface are all included in a TACCO's seabag of knowledge. Additionally, tactical procedures, enemy submarine characteristics, and operational orders must be second hand for a TACCO to make decisions in what is often critical seconds. These crucial decisions account for a victory or defeat for the crew, and possibly the nation.

The gangway to make TACCO is long and steep, but the road to mission commander (MC) is very narrow. Only accomplished pilots and TACCOs achieve this goal. The mission commander, regardless of seniority, shoulders responsibility for all phases of the mission except safety, which is always assumed by the pilot. The supreme goal of every P-3 navigator is eventually to become MC and run the total show, from briefing to debriefing with all aspects in between including flight planning, fuel planning, weapon loading, preflight, tactics, and postflight.

P-3 pilots have a right to be proud of their abilities. Along with the enlisted crew members, they can make a crew successful or unsuccessful. It is the TACCO, however, who can and must bridge any equipment gaps or crew member weaknesses. For this reason, successful TACCOs have gained the admiration of pilots and crew members alike in spite of friendly jokes and ribbings. A concise description of a P-3 crew would be: a salty group of Naval officers and sailors primarily in pursuit of submarines, directed by a TACCO (note: not a tasty Mexican dish).

A 1973 University of California, Davis graduate, Lt Luhrman completed navigator training at VT-29. He was then assigned to VP-47 at Moffett Field before duty at Mather AFB as a navigator instructor and admin officer. Lt Luhrman now has orders to the USS Enterprise.

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